Measuring Precipitation Teacher Guide

Lesson Overview:

This is an inquiry-based, hands-on activity that has been created to engage students in designing and testing a rain gauge. Throughout this one-hour lesson, students are given an engineering problem (measuring precipitation), easily obtainable materials and tools, and time to design and test their rain gauges. Students will simulate rain to test the gauge and compare their results. The comparison of results leads to a discussion about the need for a standardized calibration system to be used to get precise measurements that are reliable. Students are then introduced to the Global Precipitation Measurement (GPM) mission and learn how GPM will measure precipitation around the globe in new ways.

Learning Objectives:

- Explain the need to measure precipitation
- Use provided materials and tools to solve an engineering problem
- Realize the necessity of having a calibrated rain gauge that uses an agreed upon unit of measurement and a standardized design to ensure the reliability and validity of data collection

National Standards:

Core Idea ETS1: Engineering Design

ETS1.A: DEFINING AND DELIMITING AN ENGINEERING PROBLEM
What is a design for? What are the criteria and constraints of a successful solution?
The engineering design process begins with

- Identification of a problem to solve
- Specification of clear goals, or criteria for final product or system

ETS1.B: DEVELOPING POSSIBLE SOLUTIONS
What is the process for developing potential design solutions?

Core Idea ESS2.C: The Roles of Water in Earth's Surface Processes

- Water continuously cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation, and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS-4)

Background Information:

The Science: NASA is partnering with the Japan Aerospace Exploration Agency to develop and launch a core satellite a satellite designed to measure rain and snow from space. This international satellite mission will unite data from the GPM Core Satellite with precipitation information from a network of other domestic and international satellites that together will provide observations of rain and snow worldwide every three hours- http://pmm.nasa.gov/GPM. One of the reasons that it is important to know how much rain and snow are falling worldwide is because we only have a very small amount of freshwater available to meet society's needs. Earth is widely known as the "Water Planet", but onl about 1 percent of all of Earth's water is available to us to meet our needs - http://pmm.nasa.gov/science.

The Methodology: This lesson purposely uses an open-inquiry approach. The goal here is not for the students to make accurate rain gauges that have correct calibration on their first attempt, but rather to allow them to attempt to design a rain gauge and then test it out. This familiarizes them with the many factors that must be taken into account when designing a tool for a specific purpose. It is important that the students are allowed to make mistakes, such as not using a ruler and making measurements from the top down, in order for them to have the experience of designing and trying out a tool, and then realizing that there are certain design criteria that must be taken into account.

Materials:
A wide assortment of plastic containers for students to select from (1 for every pair of students: empty water bottles, soda bottles, etc. It is fine if they are not all clear and they should not all be the same size or shape for this particular activity)
Scissors, tape
Both metric and standard rulers
Measuring tape
Plastic graduated cylinders of different sizes
Watering can
Copies of "Measuring Precipitation" student capture sheets

Engage:

Show students the precipitation forecast map in the PowerPoint (Slide 2) and ask "what is precipitation?" (Refer them back to water cycle lessons – product of water vapor condensing in the atmosphere and falls quickly out of a cloud) and "how do meteorologists measure precipitation?" Do not answer this for them, rather share this question as an engineering problem.

Then, pull up the current rainfall data from the Tropical Rainfall Measuring Mission (TRMM) website http://trmm.gsfc.nasa.gov/affinity/affinity_3hrly_rain.html or giv students a copy of recent data to examine. Ask them to spend some time looking at the data and then record at least three things this data shows us. Discuss as a class.

Show students the "Fresh(water) Connection" Video (1:24) (Slide 3) which describes how the GPM mission will help advance our understanding of Earth's water and energy cycles, improve the forecasting of extreme events that cause natural disasters, and extend current capabilities of using satellite precipitation information to directly benefit society. You will need internet access to show this video. If you don't have internet access, you can download it ahead of time by going to the link.

Explore:

Tell the students that they will design instruments that can measure how much rain is falling. Ideally students should work in pairs. (Slide 4) Show them the available materials and tools. Ask them to spend 5-10 minutes designing their instrument on paper. Be sure to consider size an the materials that they will use. Remember, their rain gauge must collect precipitation and be able to measure how much precipitation fell during a certain time period. Ask them to show you the design before they begin constructing. Give students about 20 minutes to construct their design. Take the instruments outside and use a watering can to simulate rain. (Slide 5) The goal is not to create a perfect instrument the first time, but to get them thinking about the engineering and science behind measuring precipitation.

Throughout the process, encourage the students to think creatively and do not guide them too much. During the testing, they may get frustrated if it does not work well. Remind them that it is a first step, and that trial and error is part of the scientific and engineering process.

Explain:

Summarize their experience on the student capture sheet.

Evaluate:

Answer the questions on the student capture sheets. (Slide 6)

Show the students an actual rain gauge and discuss similarities and differences to their designs. How is the rain gauge calibrated? The tube measures millimeters, but it looks like inches, why? How do we make sure all of the rain gauges in use over the world measure rain the same way?

Show the students the short video (2:01) "For Good Measure" to show why scientists will use satellites to measure rainfall. http://pmm.nasa.gov/education/videos/for-good-measure

Elaborate/Extend:

- Give students another class period (or take their instruments home) to re-work the instrument and test again.
- Design an instrument to measure precipitation in the form of snow.
- Put up a rain gauge at your school. These are very inexpensive (~$30) and you can report the data and compare data across the country. Go to the CoCoRaHS site below to learn more! http://www.cocorahs.org/Content.aspx?page=CoCoRaHS_Schools

Teacher Notes:

Consider introducing this lesson the day before and asking students to bring their own materials and tools in for the lesson.

The creative process of developing a new design to solve a problem is a central element of engineering:

- Open-ended generation of ideas
- Specification of solutions that meet criteria and constraints
- Communicated through various representations, including models
- Data from models and experiments can be analyzed to make decisions about a design.

This is a very well-written article that explains the importance of including engineering practices in the National Science Education framework-
http://www.nsta.org/about/standardsupdate/resources/201201_Framework-Sneider.pdf

Additional Resources:

- Helpful information, background, and resources about the GPM mission and Precipitation Education website: http://pmm.nasa.gov/education/
- Tropical Rainforest Measuring Mission information and data http://trmm.gsfc.nasa.gov/
- How to make a rain gauge http://www.wikihow.com/Build-a-Rain-Gauge
- Precipitation background from USGS and National Geographic http://ga.water.usgs.gov/edu/watercycleprecipitation.html and

http://education.nationalgeographic.com/education/encyclopedia/precipitation/?ar_a=1

- NOAA Weather Service precipitation predictions and maps http://water.weather.gov/precip/
- Become a GLOBE school and share your rainfall data with other students around the world. www.globe.gov